

## Motley String Theory Overview

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### Abstract

*Copenhagen Update of Motley String Theory (aka MST) Overview includes several new results author obtained during his first two years in Denmark. Paper provides Overview of the basic principles of MST and demonstrates how it solved major problems of High Energy Physics and Astrophysics.*

*New version also describes what "elementary particles" are made of from the MST point of view and provides details of the process of their creation.*

*We mention that MST based analysis suggests that neutrinos are Majorana fermions and therefore neutrinoless double beta decay is to be detected sooner or later.*

*After that we provide evidence for the rotational symmetry of MST being the fundamental reason for the principle of Gauge Invariance, which plays key role in the "classical" Particle Physics the Standard Model is based upon as well as in the Quantum Field Theory.*

### Key words and Phrases:

Motley String Theory (aka MST), Extra Dimensions, Gauge Invariance, SU(5) Unification Model, MST based Quantum Mechanics (aka MSQM), Gravity, Supersymmetry, Elliptic Curve, Theory of Everything, ToE.

We also establish the link between Motley String Theory and minimal SU(5) unification model.

We then consider the problem of Gravity Force weakness, demonstrate how MST solved the problem via higher dimensions and established the link between our Natures *Three Fundamental Constants*: Newton's Gravity constant, Euler's gamma constant and our Universe true dimension  $D_m$ . This also explains why Supersymmetric particles (*aka sparticles*) are missing from experimental results.

We also try to venture into the New Physics beyond the Standard Model, that Motley String theory predicts.

In conclusion, we summarize the recent results of author on *Quantum Elliptic Curve (aka QEC)* and *Quantum Entanglement Mechanism* described in version 3.0 of the QEC paper. These results make it clear that *Elliptic Curve* plays Key role in God's Creation and we finally formulate a *conjecture regarding Virasoro algebra*, which may turn MST into the complete Theory of Everything.

### Key Ideas of the Motley String Theory

Motley String theory was conceived and first formulated in the late Au-

gust of 1991 after I had read several chapters of the "Superstring Theory" book by Michael B.Green, John H. Schwartz and Edward Witten [1], Russian language edition published in 1990 in late USSR.

Original paper *Motley String or from 10 to 4* was first presented to scientific community on 3rd International Conference on High Energy Physics in Rome on 11 December 2017 [6].

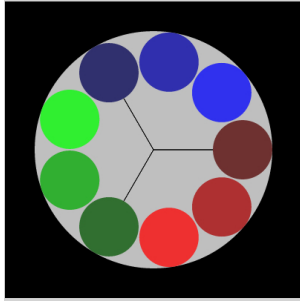
Trying to address the well known compactification problem present in all String models (Bosonic, Superstring and Heterotic) I realized that the best way to do it would be by declaring two simple Postulates:

*Postulate 1:* Every spacial dimension of the String has a unique intrinsic property, which we call "Color".

*Postulate 2:* There is force acting on spacial dimensions of the String such that it makes dimensions of complementary colors (*Red<sub>i</sub>, Green<sub>i</sub>, Blue<sub>i</sub>*) interact and unite in a colorless threads perceived as observable dimensions.

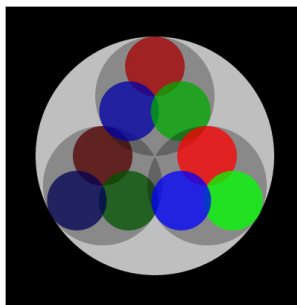
In other words, all String spacial dimensions have a unique property called *Color*, which is closely associated with *String Tension* in  $i$ -th spacial dimension,  $T(i)$ .

String state at very high energies (early universe, Planck length about  $10^{-33}$ cm) is such that all spacial dimensions of the String are in a free state similar to quark-gluon plasma of Quantum Chromo Dynamics (see Figure 1 below):



**Figure 1:** Motley string at Plank scale

During String compactification process spacial dimensions of *additive* (using classical optics term) Colors (aka Tensions) are compactified by *gluing together* and producing *gray threads* (aka **dimensions**) of matter around us (see Figure 2 below).



**Figure 2:** Motley string in Modern Cold Universe

Observable by humans dimension  $D(i)$  is simply a sum of Strings  $Red(i)$ ,  $Green(i)$  and  $Blue(i)$  additive spacial dimensions of 10 dimensional Superstring:

$$D(i) = R(i) + G(i) + B(i), \text{ where } i = [1, 2, 3] \text{ for Superstring } (1)$$

Hadronic resonances observed in collider experiments as well as computer simulations results show that so called *Regge trajectory* values  $\alpha(i)$  for quark- antiquark mesons look like:



**Figure 3:** Regge trajectories for different quark-antiquark mesons

$$\alpha(t) = \alpha(0) + \alpha' \cdot t, \quad (2)$$

$$\alpha'(i) = \frac{J}{M^2} = \frac{1}{2\pi \cdot T_f(i)}, \quad (3)$$

where  $\alpha'$  is leading Regge trajectory *slope*,  $J$  is mesons angular momentum,  $M$  is mesons mass, and  $T_f(i)$  is FERMIONIC String tension of *i-th thread* of SUPER String. Index (aka *thread or dimension*)  $i$  for Super String is  $i = [1, 2, 3]$ .

It must be clear from the formula (3) above that Regge *slopes* for mesons built of *heavy* quarks ( $c$  and  $s$  in green,  $t$  and  $b$  in red) should be *smaller* than Regge slopes of mesons built of *light* quarks ( $u$  and  $d$  in blue), since String tension  $T(i)$  is by definition Energy (aka Mass) per unit length of the string.

References to several papers on Regge slopes measurements and numerical results are to be found in the original *Motley String or from 10 to 4* paper [5] and in my first book on Motley String theory [7]. Those independent experimental and computational results provide first direct evidence in support of the Motley String theory. Original 9 spacial dimensions of our Universe (in case of Superstring), created during Big Bang some 14 Billion years ago, are compactified, or glued together and therefore can not be seen directly by human eye or detected by any currently available experimental devices. Only indirect results of *measuring Regge slope values from QCD and meson spectroscopy* may give us an idea about the deepest level of Universe structure.

Motley String compactification model treats *ALL spacial dimensions equally* and thus we avoid questions like "why some spacial dimensions are compactified while others are not". As a result, there are no standing waves of Klein compactification (so called Kaluza-Klein mass tower).

Equally important, there is no need for complicated Calabi-Yau and artificial "large extra dimensions" models invented to explain unseen spacial dimensions.

String tension  $T$ , on one hand, is related to the fundamental String length

$$l^2 = 1/(\pi \cdot T) \quad (4)$$

On the other hand, String tension can be demonstrated to be related to Regge slope  $\alpha'$  parameter of hadronic resonances

$$T = \frac{1}{2\pi\alpha' \cdot \hbar c} \quad (5)$$

Which means that the fundamental String length  $l$  can alternatively be expressed via Regge slope  $\alpha'$  as

$$l = \hbar c \cdot \sqrt{\alpha'} \quad (6)$$

$l$  is estimated to be around  $10^{-35}$  meter.

### Motley String and the Standard Model

In this section we apply Motley String theory Postulates to the Superstring model and describe how Motley String Theory solves All Six Major problems of the Standard Model.

#### 0.1. Quarks fractional charges and Confinement

Excitation (e.g. soliton) on one *original color dimension* of a colorless thread may be considered a quark of charge  $1/3$ , while excitation on two *color dimensions* of a colorless thread could be

perceived as a quark of charge  $2/3$ .

Total number of different modes of excitations on 3 primordial color dimensions equals 6 (3 single + 3 pairs) and thus we arrive at 6 flavors of quarks (up, down, charm, strange, top, bottom) known in the Standard Model [8].

In a similar way, different types of excitations not related to "color" which live on 3 colorless observable dimensions result in 6 known types of leptons (electron, muon, tau lepton, and their corresponding neutrinos  $\nu$ ) [8].

Since color force is much stronger than Electromagnetic and Weak forces, energy required to produce excitations on String primordial color dimensions is much higher than energy required to produce excitations on observable colorless dimensions. This explains why quark masses (which make up mesons and baryons) are generally much higher than masses of leptons (electron, muon, neutrinos, etc).

Interestingly, Motley String compactification model can also be applied to the Bosonic String formulated in 26 dimensions (since  $26 = 1 + 5^2$ ) and thus to the Heterotic String (combination of left-moving excitations of Bosonic string and right-moving modes of Superstring).

This leads to the rather interesting idea, that we develop further below, that vector bosons  $W^\pm$  and  $Z$  of the Weak force may live in a separate space time domain of the Universe! One way to check this would be to conduct an experiment similar to the one conducted at CERN on SPS (Super Proton Synchrotron) in 1983 when Weak force bosons were actually discovered.

Detailed description of the Proposed *W,Z Scatter Experiment* [10] is available on my personal web site as well on my Research Gate profile.

## 0.2. Motley String and Neutrinos mass and type

Motley String theory and its Color Force also offer *alternative to Higgs* mechanism of mass generation for particles and thus explains how neutrinos get their mass from *modes of excitations* of compactified spacial dimensions of Motley String.

This in turn makes hunting of the *hypothetical* Right-handed neutrinos (required by Higgs mechanism) not necessary, because neutrinos are known to be Left-handed (to take part in Weak interactions), and their mass origin is now explained by Motley String theory.

MST based analysis also suggests that neutrinos should be Majorana fermions and therefore *neutrinoless double beta decay* is to be detected sooner or later. See my paper *Neutrino is Majorana Fermion* [14] for details and two tips for experimentalists.

## 0.3. Motley String Theory and Dark Matter/Energy problem

Motley String theory also offers plausible explanation for the "Dark Matter puzzle" present in modern cosmology, which basically states that about 95% of total *observable* matter-energy of the Universe is made up of unseen "dark" matter-energy [20, 19].

According to the data available on Particle Data Group web [21] site we have for Up ( $+2/3$ ) and Down ( $-1/3$ ) quark masses:

Mass of Up quark:  $\sim 2.3$  MeV

Mass of Down quark:  $\sim 4.8$  MeV

Which means that *Quarks part of Total Mass of Neutron* should be about  $2,3 + 2 \cdot 4,8 = 11,9$  MeV.

And Quarks part of Total Mass of Proton should be about  $2 \cdot 2,3 + 4,8 = 9,4$  MeV.

While in reality masses of Neutron and Proton (composed of Up and Down quarks) are:

Mass of Neutron (U+D+D):  $\sim 1008$  MeV

Mass of Proton (U+U+D):  $\sim 940$  MeV

Which means that most ( $\sim 99\%$ ) of hadron masses come from so called "binding energy" (or quark-gluon plasma), *not from individual* masses of quarks making up hadron.

One may say that Proton and Neutron masses are mostly a result of "collective binding energy" of those up and down quarks that make them up!

According to the measurements made by five currently working (December 2019) instruments of the Hubble Space Telescope orbiting Earth at about 500 km above the surface of our planet, unseen Dark Matter/Energy of the Universe is made up of 68 percent of dark energy and about 27 percent of dark matter. While only 5 percent of the Universe is made of observable matter [19].

Much the same like hadron's masses, most of the Universe observable mass comes from Huge energy "frozen" in Motley String spacial dimensions, compactified because of the Color Force, and therefore not seen (aka "Dark energy") AND from "dark" mass of Astronomical number of neutrinos, ALL of them having very small but non zero mass.

Which means that the "Dark matter-energy problem" may in fact be seen as experimental confirmation of Motley String theory.

Careful re-calculation (e.g. using methods of Lattice QCD) of quarks, hadrons and leptons masses based on the Motley String compactification model could possibly shed new light on "dark matter-energy" mystery of modern astrophysics.

Close proximity of those numbers (observed 95% and estimated from QCD Neutron and Proton masses above 99%) seems to indicate that the compactification of Motley String's spacial dimensions due to Color Force may well be the explanation of the "Dark energy" part of the problem. And total mass of Astronomical number of all three types of evasive neutrinos may explain the missing "dark matter" part of the problem.

## 0.4. Motley String on Quark mixing and Neutrino Oscillations

For quarks of charge  $-1/3$  ( $d,s,b$ ) there are following three combinations of colors/flavors on *single colorless* spacial dimen-

sions of Motley String:

1.  $(Red_1, Green_1, Blue_1)$
2.  $(Red_2, Green_2, Blue_2)$
3.  $(Red_3, Green_3, Blue_3)$

And for quarks of charge  $+2/3$  ( $u, c, t$ ) we have another 3 possible combinations of colors/flavors on *two spacial colorless* dimensions of Motley String:

1.  $(Red_1, Green_1, Blue_1) + (Red_2, Green_2, Blue_2)$
2.  $(Red_1, Green_1, Blue_1) + (Red_3, Green_3, Blue_3)$
3.  $(Red_2, Green_2, Blue_2) + (Red_3, Green_3, Blue_3)$

On the other hand Gluons are known to have and transmit "color charge" between quarks.

Therefore, one might think that "quark mixing" between six known types of quarks above is related to exchange of Gluons between String's colorless threads.

And so called "quark mixing angle" introduced by Nicola Cabibbo in 1963 in an attempt to explain quark mixing [8, 24] is a direct result of exchange of Gluons between String's colorless threads (aka observable spacial dimensions).

In a similar fashion, we have 3 different types of excitations on *two colorless* spacial dimensions for electron, muon and tau leptons, as well as 3 more modes of excitations on *single spacial colorless* dimensions for three different types of neutrinos (electron, muon and tau neutrinos).

Now if we replace *QCD* bosons (Gluons) with Weak force bosons ( $W^\pm$  and  $Z$ ) we get exactly the same mechanism working and mixing (aka oscillating) both quarks and neutrinos!

Therefore we have to conclude that Motley String theory provides explanation for both "quark mixing" and "neutrino oscillations" detected by 3 major experiments (South Dakota, Sudbury and Super-Kamiokade) [25].

### Motley String in Higher Dimensions

In this section we have a look at how Motley String applies to Higher Dimensions, which problems can be solved and what kind of New Physics may be expected.

In 1914 Swedish speaking Physicist from Helsingfors Gunnar Nordström published revolutionary paper on his scalar theory of Gravitation where he added 5th Extra dimension and thereby integrated Gravity with Electromagnetism in a single Framework [22].

The First step towards Theory of Everything was made!

In 1919 Theodor Kaluza realized that solving Einstein's equations (published one year after Nordström's theory) for general relativity using five dimensions automatically produced Maxwell's equations for electromagnetism. He published his result in 1921 after lengthy discussions with Einstein [23].

Only recently the key pioneering role and importance of Nordström's insight into the true structure of the Universe has been acknowledged and received wider publicity [5, 7, 26].

As author first suggested in his *W,Z* Scatter Experiment proposal, and in his book on Motley String Theory [7], Motley String compactification model can easily be applied not only to 10 dimensional Superstring, giving us all known matter particles of the Standard Model, it can also be applied to the 26 dimensional Bosonic and Heterotic String theories to account for *both bosons and fermions*.

The major reason for this Universality is the very simple condition

$D(\text{imension}) = \text{time} + N^2$ , imposed by *additivity of N primordial Colors*,

required for the Motley String compactification scheme to work:

$$D = 1 + 5 \cdot 5 = 26, \text{ for Bosonic String} \quad (7)$$

and

$$D = 1 + 3 \cdot 3 = 10, \text{ for Super String} \quad (8)$$

And this apparent Universality in turn *hinted and suggested* that the Motley String Theory can be applied to even higher dimensions!

For example, the next theoretically possible dimensionality of space-time *domain* could be:

$$D = 1 + 7 \cdot 7 = 50, \text{ for, lets say, Fluids String} \quad (9)$$

And by the same token we can theoretically continue with String theories of ever Higher Dimensionalities, potentially ad infinitum! There is really no need or logical reason to stop at 26-dimensional Bosonic or Heterotic strings.

And this is where Motley String theory comes in touch with principle of *Gauge Invariance*, one of the most fundamental symmetries in both Particle Physics and Quantum Field Theory [3, 4]. In its simplest form Gauge Invariance means that one can apply certain transformations to the theory without affecting its predictions. This is why force carriers are called *gauge bosons* or *vector gauge bosons*. For example, electroweak gauge bosons  $W^\pm$  and  $Z$  are often called *Vector gauge bosons*.

Now, if we look at either Bosonic or Heterotic String bosons living in  $25 + 1$  dimensional space-time, we may realize that there are *five different* types of them, according to the formula (7) above.

Each such boson has a unique composition of Strings of Tensions  $T_i$  (aka Colors):

$$\sum_{i=1}^5 \text{Color}_i \rightarrow \text{Five Bosons} \quad (10)$$

Rotating this pentagram of *additive* Colors about circle center by  $72 = 360/N$  degrees, where  $N = 5$  is number of Colors-Tensions for Bosonic String, should not change theory or its predictions.

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This suggests that the *rotational symmetry* of Motley String may be the *raison d'être* for the principle of Gauge Invariance, which plays key role in construction of the Standard Model and in the Quantum Field Theory.

There are even more fundamental pure mathematical reasons behind this link: *Virasoro algebra* of String oscillators, which may be interpreted as infinitesimal transformations of circle into itself, and Rational Points on *Triangulated Elliptic Curve*, which again points into the direction of *Very High Dimensional* nature of Motley String Theory [11].

During my first summer 2021 in Copenhagen I resumed work on this fascinating role of Mathematical foundations of String theory and created comprehensive Research Program - paper *Elliptic Curve Dynamics* [13], which emphasized the Dynamical properties of Elliptic Curve and its Rational Points as *eigenstates* and invited all researchers working with *KdV equation, Solitons, Virasoro algebra* and dynamical systems to join this Research and contribute their own results.

The fact that Motley String theory serves as a single unified framework for such diverse subject areas as Particle Physics, Algebra and Number Theory points to the possibility of Motley String theory being our *Theory of Everything* (ToE). See Motley String book 3rd edition for more details on this [7].

One obvious question Experimentalists working on *LHC* and other particle accelerators are going to ask is "What kind of REAL Physical Phenomena" your Super High Dimensional Theory describes?

This is of cause legitimate question and today we are prepared to answer it.

Several possibilities exist here, we are going to very briefly describe some of them.

First, there may exist some new *Brain waves* related Physics with boson like carrier particles, which explains why the term *Fluids* is used in the example above.

There are numerous examples in literature (both Scientific and General) where people described phenomena related to apparently yet unknown to orthodox, down to earth Physicists, exchange of information between closely related people who happen to be on the *same brain wave* and thus can exchange feelings, thoughts and even messages simply by *focusing their thoughts on a certain subject they both know really well*.

For those who are skeptical about such phenomena, and possible Physical explanation of it, I can only recommend to have a look into the book of Carl Gustav Jung and Wolfgang Pauli entitled *Atom and the Archetype* [27].

Wolfgang Pauli, the "inventor" of neutrino, was one of the TOP Physicists of the 20th century and we can possibly trust his intuition when it comes to Physics.

Another prominent example of High Caliber Physicist turned *te-lepathy enthusiast* is brilliant Brian Josephson, who discovered the *Josephson effect*, and later was much involved in "*mind-matter interactions*" and became a director of Mind-Matter Unification Project at famous Cavendish Laboratory of Cambridge University.

Josephson co-authored several exciting books written with well known Indian Philosopher and Transcendental Meditation Guru Maharishi Mahesh Yogi.

Those are only two most *obvious and hard to ignore* examples where TOP Physicists were involved which indicate that there might be REAL Physics hidden from us at the moment!

Second possibility that we would like to briefly mention here is that the *Supersymmetric part* of the Superstring theory (so called *sparticles: gluino, wino, zino, photino, etc*), first theoretically described in the String theory context by M.B.Green and J.H.Schwartz in their ground breaking paper of 1984 [1], may well belong to those higher dimensions and as result is hidden from our present day totally 3-dimensional experimental equipment.

Third possibility is that those Fluids and higher dimensional Strings may be associated with the minimal *SU(5)* unification model of H.Georgi and S.L.Glashow, described in some detail in well known book of Chris Quigg [3].

Looking at the Table 9.1 in [3]

Branching rules for  $SU(5) \rightarrow SU(3)_c \otimes SU(2)_L \otimes U(1)_Y$

One may guess that *Fluids* String bosons correspond to the **50** representation.

And 5 Bosonic (and Heterotic) String bosons may be identified with so called *leptoquark X, Y* bosons responsible for hypothetical transitions between leptons and quarks, thus making nucleons potentially unstable in *SU(5)* model.

Another *exciting and testable result* we would like to mention here is how Motley String Theory has recently solved the well known and long avoiding explanation problem of Gravity force weakness. As a result of applying MST to the problem, author found in October 2021 that solution of the Gravity's weakness problem is hidden in Higher dimensions of Motley String and well known in mathematics harmonic series:

It has been observed that three forces the Standard Model accounts for (Strong, Weak, Electromagnetic) have sharp differences in their field strengths (i.e. coupling constants).

Electromagnetic force is defined by the *fine structure constant* which is  $\alpha = 1/137$ .

The Weak force is about 5 times stronger than electromagnetic force.

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And the Strong force which depends on the regime quarks are in (because of quark confinement) could be anywhere between 1/8 and 1.

But Gravity's strength, as we know from Newton's famous formula, is defined by the Gravitational constant, which was first measured by Henry Cavendish in 1798 to be  $G_N = 6, 6726 \cdot 10^{-11} \text{Nm}^2/\text{kg}^2$  and thus is extremely weak [28]. That is about  $10^{-34}$  times weaker than the Electromagnetic force.

The Big Question every (High-Energy) Physicist was asking was "WHAT makes Gravity so weak"?

In October 2021 paper *Dimension of the Universe* [15] author solved the problem and established the fascinating link between our Nature's three fundamental constants: Newton's Gravity constant, Euler's gamma constant and our Universe's true dimension  $D_m$ , which turned out to be Huge Astronomical number:

$$D_m = \exp\left(\frac{11}{6G_N} + \gamma\right) \quad (11)$$

The number  $D_m$  is so Big that regular computers sold in computer shops are not able to display it and one can only see text "infinity"!

On a more optimistic side, *W,Z Scatter Experiment* [10], author devised in July 2019 and initially proposed to CERN in August 2019, may be carried out TODAY on any particle accelerator, comparable with CERN SPS, and may verify the validity of the Motley String theory and String Theory in general. It is only CERN Top management decision that is required for this.

All of the above implies that *Experimental High-Energy Physics* requires *total Upgrade* of existing experimental equipment as well as radical change of our *Mind set*. We may need to begin to pay more serious attention to our thoughts and what our feelings and senses telling us. Thought appears to be Very Material "substance" and Bad thoughts can damage the World around us as we have seen many times before.

Without getting *in tune* with Higher Dimensional Universe Human race may not be able to find a way to peaceful and sustainable Future.

### Genesis of "elementary particles"

Conventional string theory explained how string oscillators generate mass (aka energy) and thus replaced point like objects (both fermions and bosons) with extended objects - strings.

Motley String theory makes it possible to look inside the "elementary particles" and describe the process of their creation and their internal structure, which is what we do in this section.

Shortly after the Big Bang - birth of our Universe, the primordial colorful dimensions of Motley String started process of Compactification.

MST Compactification included matching and then gluing together of All possible combinations of additive (aka compli-

mentary) colors.

The process started from *color* - *anticolor*, pairs gluing together, continued to finding of all *three* matching colors-dimensions  $R_i + G_i + B_i$ , then *five* additive matching colors-dimensions, then *seven*, all the way up to a certain prime number  $P_m$ , which satisfies the following condition

$$1 + P_m^2 \leq D_m = \exp\left(\frac{11}{6G_N} + \gamma\right) \quad (12)$$

When the process reached this  $P_m$ , with All primordial colors-dimensions matched and glued together in colorless threads, it stops and creation of "elementary particles" (both matter fermions and messenger bosons) is done.

Resulting *primordial objects*, which experimentalists may keep calling "particles" (we can not stop them from "visualizing" things), will somehow resemble common "bulb onions", only with continuous layers - spheres replaced with spinning and rotating compactified colorless *threads*.

Those resulting threads are made of Prime number of primordial colors- dimensions, which are essentially dividing our Universe in large number of separate *domains*, we've already mentioned above. This new perspective may give rise to a new MST based Cosmology and Astrophysics.

Moreover, the fundamental structure of our Universe described by the Motley String Theory fits quite well with Hugh Everett's original *Many Worlds Interpretation*, (aka *MWI*) of the Quantum Mechanics and the concept of *Multiverse*, derived from the *MWI* not long time ago [9]. The essential point here is that authors of both *MWI* and *Multiverse* were not working with String theory and thus believed that our Universe is Infinite dimensional, while MST makes it clear that our Universe's true Dimension is HUGE but Limited number.

There is much more to be said about the *New Quantum Mechanics* based on Motley String Theory (aka **MSQM**) and author invites curious readers to have a look into the current version 3.0 of the paper (January 2020) [18], while major new version 4.0 is being prepared.

### Motley String Theory Results

Motley String model and the Idea of String's *colorful* spacial dimensions first introduced in the "*Motley String or from 10 to 4*" article offers consistent and uniform approach to compactification problem present in all previously known String models (Superstring, Bosonic, Heterotic).

It eliminates inconsistencies of compactification mechanisms proposed earlier (Kaluza-Klein, Calabi-Yau manifolds, etc).

Motley String Theory solves several Major Problems present in the Standard Model:

1. explains number of generations and particles (6 quarks and 6 leptons) in the Standard Model.

2. explains fractional charges of quarks and quark/gluon confinement.
3. establishes the link between High-dimensional String theories and observable 4-dimensional world.
4. offers alternative to Higgs mechanism for particles mass generation and thus explains neutrino's mass and experimentally observed neutrinos oscillations.
5. offers *single mechanism* for both "quarks mixing" and "neutrinos oscillations".
6. offers solution to the "dark matter-energy" problem of modern astrophysics.

Also MST has revealed the link between *Elliptic Curve and Virasoro algebra* of string oscillators, which we discuss below.

### Elliptic Curve and Theory of Everything

In the last part of this paper we look at Elliptic Curve and the Key role it appears to play in the God's Creation.

My interest in Elliptic Curve (apart from the High school days and Kepler's second law of planetary motion) goes back to 1990-1991, when I read several chapters of "Superstring Theory" book, published in late USSR [2].

It was really striking *observation* but Virasoro algebra of string oscillators reminded me of an Elliptic Curve, where standard  $x$  coordinate is replaced by index  $m$  of string oscillators  $\alpha_m$ , while  $y$  coordinate is replaced by  $L_m$  operators - Fourier components of Energy-Momentum tensor.

See formula 6.8 in Chapter 6 of the third edition of my book on MST for details regarding those first observations and possible explanations of them [7].

Willing to deepen my understanding of Elliptic Curve and Number Theory in general I applied (in the summer of 1994) for PhD program in Algebraic Number Theory of McGill University in Montreal, shortly after arriving there as refugee claimant.

Professor *Maruti Ram Murty* kindly paid my tuition fees and McGill University produced PhD student ID card (seen on Math page of my web site) and all required documents.

But Immigration du Quebec clerk turned down my application for student visa and I could not legally continue my study. So I attended NT seminars and lectures organized by CICMA in Montreal and conducted independent research.

In March of 1996 I came to Canadian Immigration office in Montreal and asked them to buy me a ticket to my native St. Petersburg.

In May 1996 I discovered new simple parametrization of Elliptic Curve, based on ancient formula for area of triangle, generally attributed to Heron. The resulting method and my first paper on Elliptic Curve was entitled *Triangulation of Elliptic Curve*, aka TEC, which is available on my web site from around 2010 when I got settled in Stockholm and on my Research Gate profile.

Research on Elliptic Curve Rational points led me to devising first *GYM algorithm* (2015) for *search* of Rational Points and then to *Elliptic Curve ABC ansatz* and algorithm (2017) for *generation* of Rational Points. Both algorithms are based on the Method of Triangulation and are quite simple and elegant.

These two lines of my research (MST and Elliptic Curve) remained almost disconnected until August 2017 when my paper *Elliptic curve ABC ansatz* described the new simple *ABC ansatz* and algorithm.

Implementation of the ABC algorithm in my Java pet project *Elliptic Curve Applet* version 7.0 clearly demonstrated that majority of Rational Points on Elliptic Curve were in fact generated by several  $(k, l, m)$  triplets used for Elliptic Curve Triangulation and thus were *degenerate* in a way similar the to the Hydrogen Atom ground states!

In August 2019 my paper *Hydrogen Atom and Elliptic Curve* [11] had established the *correspondence* between Hydrogen atom bound states (aka energy levels) and Rational points on some special Elliptic Curve using both the GYM and ABC algorithms. It became clear to me that there must exist some Very Special Elliptic Curve that contains information about All energy levels of Hydrogen and other hydrogenic atoms in the Universe! Derivation of the **God's Curve**, as I called that Special Elliptic Curve, had to wait till October 2020.

Curious about the book *Atoms, Molecules and Quanta* [16] several high profile physicist mentioned in their work, I came to the KTH library in Stockholm and found this precious book in the Rear book collection.

The rest was just a matter of calculations.

The wonderful book of Ruark and Urey is so well written and illustrated and contains such *original* and fundamental material not available in standard books on Quantum Mechanics, that on the same day I finally derived the new equation of Quantum Elliptic Curve (two linked curves actually)!

But the really Tricky part of it was actually hidden Very Well! At first I did not *fully* realize why there were *two linked elliptic curves* there. Even though my paper on Hydrogen Atom energy levels had described similar solution with two linked triangles [11]. The Excitement was too high I suspect. And very unfortunate events in Stockholm were not helping me to focus on physics at all. Quite opposite was true.....and I had to leave my apartment and Sweden.

After first hurdles of my evacuation to Copenhagen (on 30 January 2021, after exactly 11 years in Stockholm) were over and I resumed my research (in quite different circumstances), I had finally realized that the **Quantum Entanglement Mechanism** was hidden there! Version 3.0 of my paper *Quantum Elliptic Curve* [17] added new section describing the Entanglement Mechanism along with two methods that can be used to change state of either one or both particles forming *EPR - pair* (aka Bell state).

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And my original observation regarding role of Elliptic Curve in the String Theory and in the Universe has eventually come to the following *Conjecture*: Virasoro algebra of string oscillators can be transformed to an Elliptic Curve (or two linked curves), which contain fermionic and bosonic energy (aka mass) spectra. That is, Fermionic Elliptic Curve contains energy levels (aka masses) of Fermions and Bosonic Elliptic Curve contains energy levels (aka masses) of Bosons.

Time will tell if there is something behind this Idea...

Today we can say with certainty that Elliptic Curve is Super Special and Puzzling Mathematical object which plays Key Role in God's Creation.

*Elliptic Curve Dynamics* Program - paper [13] is all about Investigating this subject matter.

Apparently there are some benefits in becoming a *refugee* in this irrational and chaotic world. As a result of my "forced relocation" (aka Escape) to Denmark, number of people aware of Motley String Theory and my research in general has increased considerably. My language skills now include basics of the very advanced Dansk - language of Vikings, Tycho Brahe, H.C. Andersen, H.C. Ørsted, Niels Bohr, Lars von Trier and other famous Danes, and my Research results have reached new heights, to some degree reflected in my Research Gate profile. Lord works in mysterious ways, as they say.

## Conclusion

In the present paper we gave an Overview of Motley String Theory and described results it produces when applied first to the 10-dimensional Superstring model, reproducing all available experimental data, and then to Higher Dimensions. We have seen how Motley String Theory solved several Major Problems of High Energy Physics, which the Standard Model could not explain during some 60 years of its existence.

We have described internal structure and creation mechanism of so called "elementary particles", which turn out to be rather complex high-dimensional objects somehow resembling the **bulb onions**.

Solution of the Gravity's Extreme Weakness problem led us to establishing fascinating link between our Natures three fundamental constants: Newton's gravity constant, Euler's gamma constant and our Universe true Dimension  $D_m$ .

We also mentioned the *W,Z Scatter Experiment* proposal, which could help us verify Motley String theory on High Energy particle accelerator similar to SPS in CERN and at the same time confirm *high-dimensional* structure of our Universe. The Proposed Experiment is quite similar to the one CERN conducted in 1983 on SPS when  $W^\pm$  and  $Z$  bosons were discovered.

Several *neutrinoless double beta decay* experiments, currently underway, may confirm neutrinos *Majorana* type, expected from MST based analysis.

We demonstrated how Motley String Theory can be applied un-

changed to the higher than 26 Bosonic Spatial dimensions and what kind of new *Mind and Supersymmetry related Physics* may be hidden from us in those Higher Dimensions.

We also described the plausible link between Motley String theory and minimal  $SU(5)$  unification model.

Finally, we have discussed the Mathematical Foundations of the String Theory, which give us reasons to think of the Key role **Elliptic Curve** plays in God's Creation. We have also mentioned the *Elliptic Curve Dynamics* Research Program - paper, which may be used to clarify and deepen our understanding of this subject. Fusion of pure Mathematics (Algebra and Number Theory) and Physics manifested in Motley String Theory is sure sign of Theory of Everything (ToE).

Looking at the section 9.7 "Assessment" of Chris Quigg's book [3] on Gauge Theories we may conclude that Motley String Theory can answer (at least qualitatively) most of the questions that "classical" Particle Physics based on the Gauge Invariance Principle can Not answer, which gives reasons to think that Motley String is our *unique candidate for the Theory of Everything!*

**"Ære være Herren Gud for et saligt glædesbud"**

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